



December 7, 2001

Dear Stakeholder:

The Rocky Flats Cleanup Agreement (RFCA) Stakeholder Focus Group will meet at the Broomfield Municipal Center at One DesCombes Drive on December 12, 2001 from 3:30 to 6:30 p.m.

As promised, the substantive discussion on cleanup options will begin in earnest at next Wednesday's Focus Group meeting. We have laid out an ambitious agenda (the first of several ambitious agendas). The agenda for the December 12, 2001 meeting is enclosed (Attachment A). We will discuss the following topics:

- Task 3 Peer Review and Wind Tunnel Technical Review - update
- Timeline for Cleanup and its Affect on Focus Group Discussions
 - Overview of scope and schedule - now through 2006
 - FY-2002 Environmental Remediation scope
 - How RSAL and Endstate discussions must fit into the broader schedule
- Cleanup Funding Overview
 - Recap - overall Closure budget and core elements
 - Overall budget for Environmental Remediation through Closure
- Cleanup Options That Have Been Identified
 - Options for surface remediation, subsurface remediation, surface water protection, stewardship
 - For each option: baseline assumptions and funding differences between options and baseline

The following materials will be emailed to you on Monday to help prepare you for our discussions:

- ER Budget overview as it now stands
- Cleanup schedule
- Summary table of cleanup options
- Syllabus for Focus Group over next several meetings (provided first to Agenda Group for review).



ADMIN RECORD

1/29/44 Q
DOCUMENT CLASSIFICATION
REVIEW WAIVER PER
CLASSIFICATION OFFICE

SW-A-004426

The handouts from the November 28, 2001 RFCA Focus Group meeting are enclosed as Attachment B, and include:

- Interests and Path Forward presentation, and
- November 28, 2001 meeting packet materials.

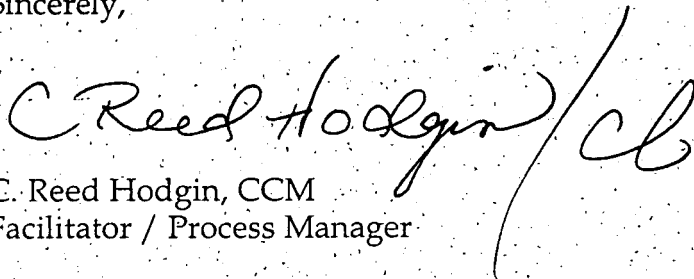
The RSALs Working Group meeting notes for November 29 and December 6, 2001 are Attachment C.

Attachment D is the second Wind Tunnel Peer Review.

I suggest that you also dig back through your previous meeting packets for applicable information. It may be useful to compile this information in the End State Notebook that we provided you some months ago (please contact Christine if you did not receive one).

You may call either Christine or me if you have any questions, comments, or suggestions concerning the RFCA Stakeholder Focus Group or the upcoming meeting.

Sincerely,

A handwritten signature in cursive script that reads "C. Reed Hodgins" followed by a large, stylized flourish that resembles a slanted "C" or "H".

C. Reed Hodgins, CCM
Facilitator / Process Manager

RFCA Stakeholder Focus Group Attachment A

Title: Agenda for December 12, 2001 Focus Group Meeting

Date: December 7, 2001

Author: C. Reed Hodgins
AlphaTRAC, Inc.

Phone Number: (303) 428-5670

Email Address: cbennett@alphatrac.com

RFCA Stakeholder Focus Group Meeting Agenda

When: December 12, 2001 3:30 - 6:30 p.m.

Where: Broomfield Municipal Hall, Bal Swan and Zang's Spur Rooms

- 3:30-3:40 Ground Rules, Agenda Review, Objectives for this Meeting
- 3:40-3:50 Task 3 Peer Review and Wind Tunnel Technical Review - update
- 3:50-4:20 Timeline for Cleanup and its Affect on Focus Group Discussions
- Overview of scope and schedule - now through 2006
 - FY-2002 Environmental Remediation scope
 - How RSAL and Endstate discussions must fit into the broader schedule
- 4:20-4:50 Cleanup Funding Overview
- Recap - overall Closure budget and core elements
 - Overall budget for Environmental Remediation through Closure
- 4:50-5:00 Break
- 5:00-6:10 Cleanup Options That Have Been Identified
- Options for surface remediation, subsurface remediation, surface water protection, stewardship
 - For each option: baseline assumptions and funding differences between options and baseline
- 6:10-6:25 Path Forward for Focus Group Over Next Several Meetings
- 6:25-6:30 Review Meeting
- 6:30 Adjourn

4

RFCA Stakeholder Focus Group Attachment B

Title: November 28, 2001 RFCA Focus Group
Presentation: Interests and Path Forward

Date: November 28, 2001

Authors: Reed Hodgins

Phone Number: (303) 428-5670

Email Address: cbennett@alphatrac.com

RFCA FOCUS GROUP

Interests and Path Forward

Reed Hodgkin

November 28, 2001

Facilitator Evaluation

- At 11/14/01 FG Meeting - promise to evaluate PG and propose path forward
- Have reflected on discussions and interactions at FG
- Have had a few discussions with members
- Ready to present observations and recommendations

My Observations

- Interests operating in the discussion
- Barriers to agreement
- A bounded discussion
- How all interests can be served
- The relationship between the Focus Group and other community involvement operations
- A path forward for the Focus Group

Interests in the Discussion

Get the Best Cleanup Possible

**RFCA
Agencies**

CAB

**Local
Governments**

**Future
Generations
Protection**

**Wildlife
Protection**

RFCA Stakeholder Focus Group

Interests in the Discussion

Get the Best Cleanup Possible

**RFCA
Agencies**

CAB

**Local
Governments**

**Future
Generations
Protection**

**Wildlife
Protection**

RFCA Stakeholder Focus Group

Interests in the Discussion

Get the Best Cleanup Possible

**RFCA
Agencies**

**Local
Governments**

**Future
Generations
Protection**

- Risk / dose compliance
- Surface water compliance
- Effective Stewardship program
- Work within available budget
- Accelerated closure
- Include community priorities

RFCA Stakeholder Focus Group

Interests in the Discussion

Get the Best Cleanup Possible

**RFCA
Agencies**

**Local
Governments**

**Future
Generations
Protection**

- Risk protection for residents / site users
- Protection of water resource
- Effective stewardship program
- Surface contamination removal
- Subsurface contamination removal

RFCA Stakeholder Focus Group

Interests in the Discussion

Get the Best Cleanup Possible

**RFCA
Agencies**

**Local
Governments**

**Future
Generations
Protection**

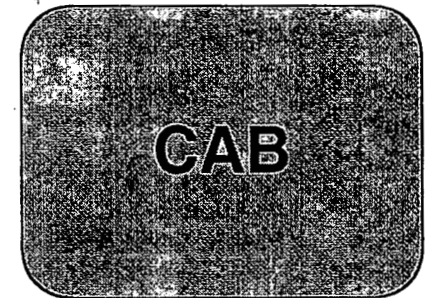
- Surface contamination removal
- Subsurface contamination removal

RFCA Stakeholder Focus Group

Interests in the Discussion

Get the Best Cleanup Possible

- Risk protection for residents and site users
- Surface contamination removal (eventually to background)
- Subsurface contamination removal (eventually to background)



**Wildlife
Protection**

Interests in the Discussion

Get the Best Cleanup Possible

- Risk protection for wildlife
- Protection of ecosystem / habitat
- Risk protection for wildlife workers
- Risk protection for refuge users

CAB

**Wildlife
Protection**

Protection

RFCA Stakeholder Focus Group

10

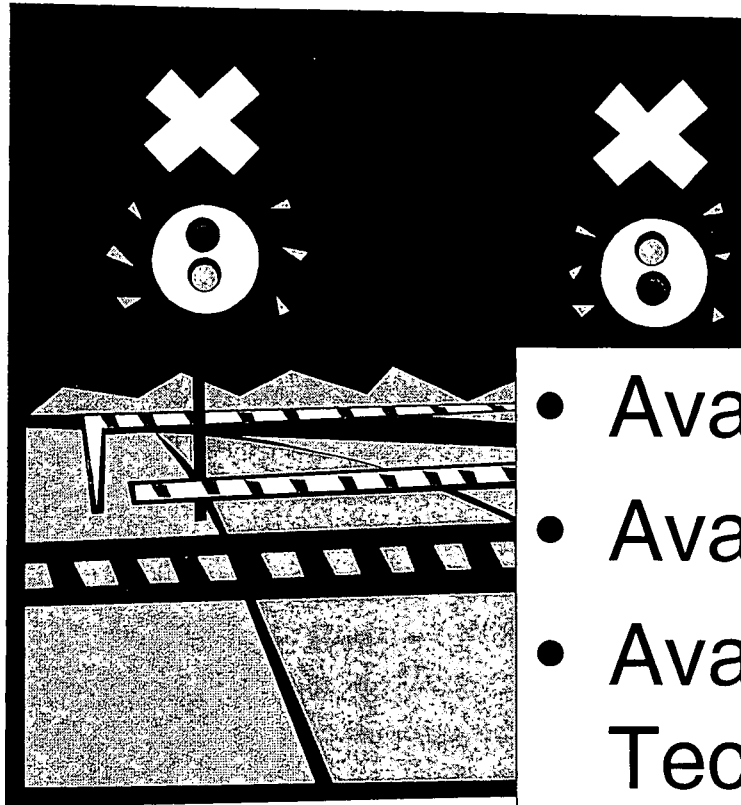
15

A Few Fundamental Interests

- Risk / dose compliance
- Surface water compliance
- Surface contamination removal
- Subsurface contamination removal
- Effective stewardship

- Wildlife / habitat protection
- Ensuring commitments

Barriers to Agreement



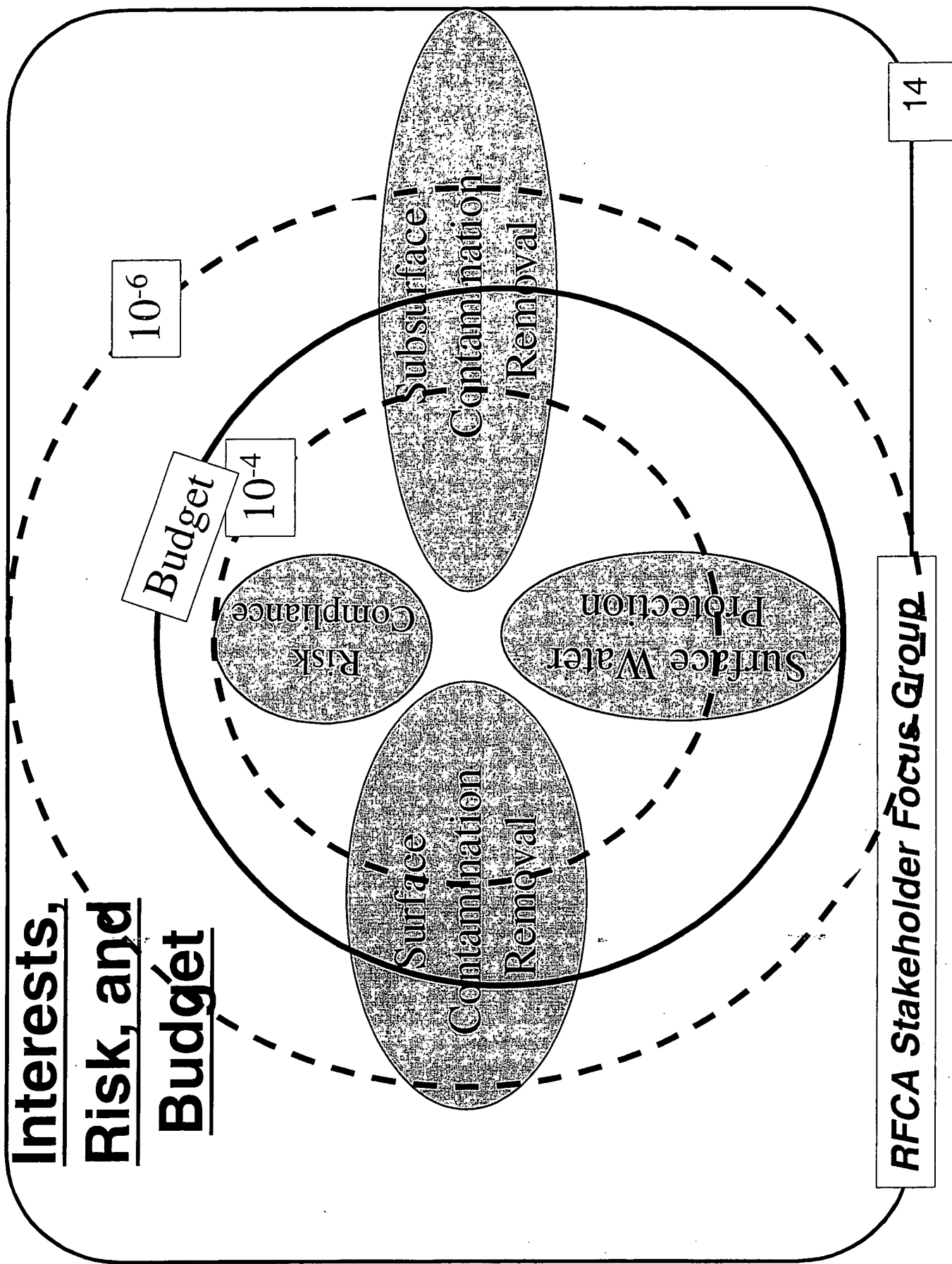
- Available Funding
- Available Time
- Available Technology
- Trust

What is NOT a Barrier to Agreement

- Interests are NOT in Conflict
- Possible exception: wildlife / ecosystem protection
- At issue is how much of each interest can be met

8

Interests,
Risk, and
Budget



Conclusions

- All interests can be met to some extent with available budget
- Not all interest can be fully met with available budget

A Bounded Discussion

- A bounded discussion will occur:

“How can Rocky Flats best be cleaned up with the available budget?”

- This discussion will occur and will occur now (903 Pad Cleanup is a driver)

Two Key Questions

- Can the Focus Group contribute to the bounded discussion?
- Can the Focus Group support the interests that are not fully met by the bounded discussion?
- Recommendation: Yes to both

How All Interests Can Be Served

- A bounded discussion in the Focus Group:
“What are the options for cleaning up Rocky Flats within the available budget and how do these options serve the interests at the table?”
- Evaluate these options against CERCLA criteria and interests to help identify “best” option or options

How All Interests Can Be Served (Cont.)

- Once the bounded discussion is in hand
...
 - Identify options for furthering interests not fully met in bounded discussion (e.g., more risk reduction, more source removal)
 - Identify and compile information so that interested stakeholders can pursue those options (NO commitment from Agencies to pursue)
 - Evaluate those options in the Focus Group

Other Community Involvement Operations Are Recommendation- Oriented

- RFCLOG
- RFCAB
- Stewardship Working Group
- One-on-One Discussions
- Formal Public Comment

Focus Group Interaction With Recommendation-Making Groups

- Recommendation: Focus Group expands scope to directly support recommendation-making groups
- Develop and evaluate options that other groups can use in their recommendation formulation
- This is partly a formalization of what informally exists, but with more deliberate coordination

A Recommended Path Forward

- Focus Group identifies cleanup strategies for use of available budget
- Focus Group identifies information needed to evaluate strategies and Agencies compile
- Focus Group evaluates strategies against CERCLA criteria and interests

A Recommended Path Forward

- Focus Group identifies RSAL strategies and evaluates them against interests (maybe?)
- Focus Group identifies strategies for moving beyond bounded discussion
- Focus Group identifies and Agencies compile information to serve these discussions

A Recommended Path Forward **(Cont.)**

- Focus Group evaluates “beyond bounded” scenarios against CERCLA criteria and interests (maybe?)
- Focus Group coordinates with recommendation-making groups so that information and analyses help serve the needs of these groups

**RFCA Stakeholder Focus Group
Attachment C**

Title: RSALs Working Group Meeting Notes for
November 29 and December 6, 2001

Date: December 7, 2001

Authors: Sandra MacLeod

Phone Number: (303) 966-3367

Email Address: sandra.macleod@rf.doe.gov

NOTES FROM RSALs WORKING GROUP MEETING ON 12/6/01

ITEMS COVERED ON 12/6:

1. Discussed parameters for uranium dose calculations.
2. Discussed parameters for risk equations for uranium.
3. Discussed plant uptake.

ACTIONS

Action Item	Who	When	Notes
Contact Ward Wicker for review of Task 3 plant uptake factors	Carl Spreng	12/13/01	Review to include plant ingestion pathway for Pu/Am; suggestions for plant uptake for U and non-rads (Rocky Flats specific data, if possible); & attendance at next working group meeting.
Provide: 1. background U soil concentration values; 2. range of sizes of U hot spots; 3. hot spot methodology.	Carl Spreng	12/10/01	
Provide wildlife refuge worker scenario info.	Carl Spreng & Diane N.	12/13/01	
Determine if EPA Headquarters will review the Task 3 report.	Tim Rehder	12/13/01	
Review RAC work for U approach.	Jim Benetti	12/13/01	
Do RESRAD dose calculations for surface RSALS with varying AOC.	Jim Benetti	12/13/01	
Follow-up with Susan & Phil Goodrum on external gamma (background in soil screening guidance & difference between RESRAD & risk equations).	Mark Aguilar	12/13/01	
Prepare distribution or point value for plant root uptake (for risk equations).	S. Griffin	12/13/01	
Perform dose & risk calculations for uranium for surface RSALS.	Working Group		After parameters are finalized.

DECISIONS

Agreed on 0.4 for indoor gamma shielding factor.

NEXT MEETING: THURSDAY, 12/13/01, 8:30 a.m., at CDPHE, Room B2B

B2B is on the east side of the 2nd floor of Building B. Everyone needs to enter through the front door of Building A and register at the front desk.

Agenda Items:

1. Discussion with Ward Wicker (pending his availability).
2. Discuss Jim's results.
3. Come to resolution on area factor and plant uptake factor.
3. Go through plant uptake factors.

32

NOTES FROM RSALs WORKING GROUP MEETING ON 11/29/01

ITEMS COVERED ON 11/29:

1. Parameters for uranium calculations

ACTIONS

Action Item	Who	When	Notes
Find out if CDPHE can fund review of Task 3 by Ward Wicker.	Diane N.	12/6/01	Review to include plant uptake used for Pu/Am; suggestions for U and non-rads; & attendance at future working group meeting. (If CDPHE cannot fund, EPA will determine if it can fund).
Determine if EPA Headquarters will review the Task 3 report.	Tim Rehder	12/6/01	
Review Jim's paper on uranium parameters.	All working group members	12/6/01	<i>Bring comments or agreement to 12/6 meeting.</i>
Follow-up with EPA Headquarters on external gamma (background in soil screening guidance & difference between RESRAD & risk equations).	Jim Benetti	12/6/01	
Prepare distribution for plant root uptake & look at gamma shielding factor (for risk equations).	S. Griffin	12/6/01	
Perform dose & risk calculations for uranium for surface RSALs.	Working Group		After parameters are finalized.

DECISIONS

None

NEXT MEETING: THURSDAY, 12/6/01, 8:30 a.m., at
ROCKY FLATS B060

Agenda Items:

1. Discuss Jim's paper on parameters for uranium dose calculations.
2. Discuss parameters for risk equations for uranium.
3. Go through action item table.

**RFCA Stakeholder Focus Group
Attachment D**

Title: 2nd Wind Tunnel Peer Review

Date: December 7, 2001

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Email Address: cbennett@alphatrac.com

PEER REVIEW
of
**Wind Tunnel-Based Characterization of Wind Resuspension
for Development of Radioactive Soil Action Levels at Rocky Flats.**

Response to: Evaluate the appropriateness of the wind tunnel technology used in studies at Rocky Flats for developing wind resuspension values to be used in establishing Radioactive Soil Action Levels at Rocky Flats.

General Comments: The appropriateness of this wind tunnel application should be thought of in the proper context. The wind tunnel is one of many tools and it has both limitations and advantages. The wind tunnel is artificial in many ways. It is designed in a way that controls the mean wind speed but cannot reproduce the scale (size) of wind speed variations ("turbulence"). The protocol used--to increase wind speed through a succession of changes each few minutes--is unnatural, but has been standardized as a technique to obtain estimates of "erosion potential" for comparison between different surface conditions. The ground area exposed to controlled wind erosion is only about one square meter in the larger tunnel used, but the variability should be significant between adjacent square meters due to differences in surface condition. So testing several one-square-meter plots becomes essential to increase the number of samples and to improve the statistics. Using this method the equivalent 10-m wind speeds reported are very extreme; a 95-mph speed persisting for an hour or more has a very low likelihood at Rocky Flats. Yet, the erosion potentials so obtained have use in establishing Radioactive Soil Action Levels, providing that we expect that the extreme erosion potentials observed are unlikely to ever exist in nature.

The scientific assumptions for obtaining erosion potentials with this wind tunnel method are that the renewal of the available soil is an avalanching, continuous process and that the loss rate from the surface is unchanged throughout. Both of these assumptions are subject to criticism. It is a matter of controversy that erosion only occurs after a certain wind speed threshold. The threshold concept came after early research showed that "saltation" of large particles can be visually observed to occur at certain high wind speeds, and thus at higher speeds these large particles bombard the surface and cause smaller-particle ejecta in an avalanching effect. More recent observations show that there is an emission of small particles at speeds below the observed thresholds for saltation, and while this fact amounts to a relatively small emission loss, it affects the surface condition. That is, in nature the time lapsed and the changes in the surface condition between strong winds have an influence on the availability of small particles to be ejected. Even the authors have observed suspended particles at the inlet of the wind tunnel and these seem to be related to the reported, outside wind conditions, clearly below the limit where the authors report their lowest-speed erosion potentials. It is also possible that the loss rate should change as material is removed. In the protocol, each test involves step increases in wind speed and adds accumulated emissions from each step. In the wind tunnel saltation, the onset of avalanching may be a product of the peculiar small scale of turbulence, and more soil might be available than under natural winds.

Whatever the pros and cons of the wind tunnel might be, it remains a helpful tool. The following questions were posed by members of the Rocky Flats Cleanup Agreement Stakeholder Focus Group:

1. *Has this equipment been thoroughly tested for operations like those for which it is being used at Rocky Flats?*

This reviewer feels that the equipment is in good standing with the scientific community. The equipment is of a design that was frequently used in publications by Dale Gillette beginning over twenty years ago. Those publications were peer reviewed and collectively represent an acceptance that is as close as one can come to a scientific "pedigree". This particular wind tunnel method used at Rocky Flats, had its origins in the studies accepted by EPA to estimate fugitive dust sources. While the data from EPA documents are inappropriate for the application at Rocky Flats it appears that the method is scientifically acceptable. The community must understand that we can weigh the pros and cons of the method, but it is after all only another tool. It is artificial, as stated previously, but the results are useful if we are careful how we use them.

Is the review of sufficient quality and thoroughness to evaluate the applicability of the approach to the problem at Rocky Flats? Does the review show that the wind tunnel approach is appropriate and adequate for this purpose?

This reviewer will make an attempt to show that the observations made by the wind tunnel method provide a set of data that are sufficient to proceed with the determination of Radioactive Soil Action Levels. The data are internally consistent, statistically acceptable, and rather complete. In this sense the wind tunnel study has achieved what I would call "quality and thoroughness" even as I acknowledge that there are limits to the use of the data. For example, I hope to show (in answers to other questions) that particular observations are sufficient to bound the worst case possible inhalation scenario, while I acknowledge that normalizing the emission potentials to 95-mph winds are a bit of an extreme. The wind tunnel study was very appropriate to examine the influence of wildfire effects on inhalation exposure; perhaps it was the ideal method considering the alternatives for field studies of that nature. We can always debate if a study was adequate. In my view, there is no need for further study if all that we need is to determine Radioactive Soil Action Levels. No study may be more definitive in that respect.

2. *Is the pitot tube methodology employed in the wind tunnel adequate for characterizing the wind profile in the wind tunnel while it is operating?*

The pitot tube is essential even though various electronic velocity probes (hot film, hot wire, etc) would be more elaborate. (One can always calibrate a pitot tube against an electronic secondary standard). But the pitot tube is perhaps the only device that would withstand the bombardment by airborne particles. While it was perhaps not easy to make profile measurements with the pitot tube, the surface roughness data obtained from the velocity profiles appear to be quite good. The main purpose of the roughness data was to convert the wind tunnel speed to the effective speed at 10-m height. That factor is not particularly sensitive to slight errors in roughness. I doubt if we would have any significant change to the results by finer profile measurements.

3. *Is the wind tunnel working section long enough so that the desired wind conditions can develop and remain stable for characterizing resuspension?*

This is a good question. We rely on the design adequacy of the inlet flow conditioning to substitute for a long tunnel. There is a five-to-one contraction in flow, a honeycomb section, and a screen section upwind of the test section. In addition to other things, these all serve to make a uniform flow cross-section and to precondition the boundary layer. While details are not discussed in the reports, this is not a new tunnel design, and I believe that the design is adequate. The ratio of the test section length to the roughness length is greater than 100:1 which is a good indicator of boundary layer development. The main reason for assuring boundary layer development and stability is to characterize and control the shearing stress on the surface, which is proportional to the square of the friction velocity. The wind tunnel does that adequately.

4. *Does the wind tunnel methodology adequately account for the effects of small-scale variations in surface cover and surface roughness, including turbulent variations on a small scale?*

One limitation of this wind tunnel design is the small working area of the tunnel on exposed soil. The larger (reference) tunnel has an exposed area of one square meter and the smaller tunnel has exposed about 0.4 square meter. In order to characterize differences in surface cover and surface roughness, the tunnel has to be moved several times (3 to 6 times within a set of tests) and the tests replicated. That gives satisfactory statistics between replicate results.

Turbulent variations on a small scale are abnormal in this wind tunnel, however, because the inlet flow conditioning (contraction section, honeycomb, and screen) serves to remove the natural large-scale turbulence and to create small-scale turbulence. The result is that with the turbulence scale is so small and the applied mean speeds so large, that the flow variations are high-frequency causing particles on the surface to oscillate, something that would not be as important in nature. The concept of soil binding is that the release of any particle (radioactive, etc) does not occur until the aggregate containing the particle is stressed by force imbalance. Oscillations cause different forces than direct shearing stress. An abnormal surface particle behavior may explain why dust concentrations as measured by the tunnel effluent appear to this reviewer to be very large, and gives cause for concern that the tunnel method over estimates emission loss and erosion potential. But if true this effect is not a "show stopper" for Rocky Flats. In my opinion, the larger values of PM-10, TSP, and erosion potential reported may be construed as upper bounds, and thus provide a factor of conservatism to protect against unusual inhalation exposure.

5. *Is it true that roughness of the surface may act to dam or retard rather than release surface particles in unidirectional wind flow? If so, how can this equipment accurately account for this reality?*

At the high speed in the wind tunnel it is likely that once a particle is in motion it remains in motion until it exits the test section. There is really no time for deposition of particles. At 40 mph the time to traverse the test section is $[(3.5 \text{ m}) / (19 \text{ m/s})] = 0.2 \text{ s}$, and the deposition velocity is about 1- 5 cm/s so deposition distances are less than 1 cm.

6. *Is the sampling period appropriate for wind resuspension at Rocky Flats? Is the supply of suspendable material being depleted well before a test is over? Does this artificially affect the results of the experiments (e.g. fictitiously low average resuspension rate because some sampling was performed when there was no material left to resuspend)?*

The observations made with the DustTRAK electronic particle counter are revealing about the erosion process. Using the protocol of a step change in wind speed each few minutes, there follows a burst of particles represented by a peak in the DustTRAK record. There may be a few more minor peaks and then the particle concentrations return to a background level. There follows another protocol speed change in two or four minutes, another burst of particles, and so on. The process is definitely not continuous. So of course, the suspendable material is depleted at that wind speed step until the speed is changed. The sampling period is "appropriate" for this particular protocol.

The soil material measured at the tunnel exhaust is the integration of all the observed peaks and the data are summed over all previous wind speed step changes. There is very little "wasted" time observing low resuspension. The whole process takes 25-40 minutes and then the tunnel is moved and another replicate observation made. The process is artificial but standardized to measure the erosion potential assuming that the factors controlling the loss rate have not changed with each step.

7. *How well does the wind tunnel reproduce the actual meteorological conditions expected during high winds at Rocky Flats? Are there any field validation data to demonstrate this?*

The wind tunnel reproduces only the surface shearing stress caused by the wind at Rocky Flats. (The surface shearing stress is a force per unit area on the soil surface, directed in the downwind direction.) The surface shearing stress is proportional to the square of the "friction velocity", which is the term measured and reported in the wind tunnel study reports. The friction velocity outside the wind tunnel can also be measured at Rocky Flats and it is easily expressed as drag coefficient multiplied by the wind speed. The wind tunnel was not designed to control anything else, and has an artificial scale of turbulence as pointed out before.

The wind tunnel causes resuspension only by increased shearing stress on the surface (measured by friction velocity). Wind records from Rocky Flats show that 95% of the time the winds are less than 18 mph, and from the roughness values measured in the wind tunnel 95% of the time the friction velocity would be less than 50 cm/s. But the wind tunnel results are expressed for 95 mph winds and friction velocities of about 250 cm/s. So at 95 mph the friction velocity is 5 times the 95th percentile value, and the shearing stress (proportional to the square of the friction velocity) is 25 times the 95th percentile values observed at Rocky Flats. By extrapolation from the frequency distribution of winds observed at Rocky Flats I estimate that the likelihood of sustained 95-mph winds at Rocky Flats is just a few hours each year. We have indeed chosen an extreme case.

8. *Does the wind tunnel realistically and adequately account for the vertical wind velocity and variations in it?*

The average vertical velocity at the ground surface is zero, both in the wind tunnel and outside the tunnel. Only the variations (turbulence) in the vertical wind velocity are important, and the "typical" (root-mean-square) vertical variations are about the same as the friction velocity. In the wind tunnel, however, the variations are expected to be of short duration (high frequency) compared to the outside vertical variations. That is what is meant by "small scale" turbulence as compared to natural turbulence. We know that the wind tunnel is artificial in this regard, and it is my opinion that at high speeds the high frequency turbulence would cause abnormal particle behavior on the soil surface, in that the oscillations of the particles would cause an over estimation of erosion potential. I am willing to accept that possibility because it would lead to an upper bounding case for estimation of inhalation exposure, and an additional protection for human health.

9. *High winds at Rocky Flats involve rapid fluctuations in wind speed, wind direction, and turbulence. How important are these effects to resuspension? Does the wind tunnel reproduce these effects adequately for meeting the goals of the project?*

This answer is related to the discussion of question 8. The rapid fluctuations in wind speed are taken into account through the friction velocity in the wind tunnel. The turbulence outside at Rocky Flats may be large, but we think of it as "gusts" that are large in scale (tens of meters) as compared to the wind tunnel where the turbulence is more like 0.01 meter in scale. We only expect that the wind tunnel controls the friction velocity on the surface. I can accept this turbulence scale difference because I believe that it leads to an over estimate of suspended dust as I discussed before. I am willing to accept the results of the wind tunnel because much of the data are very useful, the wind tunnel results are perhaps the best we could ever hope for to look at effects of wildfire, and I believe we can develop protective Radioactive Soil Action Levels from these results.

10. *How effective is the wind tunnel at resuspending particulates of different sizes? Does the wind tunnel have a high efficiency for particles of small, medium, and large size? Here "efficiency" means how well the equipment mimics actual conditions in the environment.*

The particulates that are resuspended are rarely primary particles. That is, they are clusters of many kinds and sizes of particles called aggregates. The resistance to wind erosion thus depends on the strength of the aggregate bonding. If a surface is left undisturbed it naturally forms stable aggregates; the bonding is affected by many factors. A good example of this is the effects of driving a vehicle over a surface. We have all seen that the compression due to vehicle tires destroys aggregation and the downdraft from the car will resuspend dust. Yet the primary particle distribution remains the same.

The wind tunnel provides sufficient shearing stress at the surface to suspend particle aggregates in the size ranges far greater than the respirable-size particles. It is the large aggregates that reach a limit, because the effect of gravity is to counter the resuspension. All the small particles/aggregates would be transported away. That is, the forces countering the lifting forces are too small and the particles go with the air into the tunnel exhaust. As discussed previously, the residence time of a suspended particle in the wind tunnel test section would be less than about 0.2 seconds. Redeposition is negligible.

11. *If the effectiveness of the wind tunnel at reproducing resuspension is good at various particle sizes, is it good at different wind speeds? Since the particles of different sizes have their own specific thresholds resuspension and transport, does this equipment detect the thresholds accurately?*

The wind tunnel does control wind speed and can thus be used to estimate erosion potentials as a function of wind speed. There is no independent way to check this other than long term monitoring, but surface conditions change during long monitoring periods. The wind tunnel provides a means of measuring the full range of wind speed effects on erosion potential and can obtain replicates of the measurements in a short enough time period that the surface condition remains relatively constant as far as we know.

I discussed under General Comments that the threshold concept is debatable. But as far as the goal of this project is concerned, the erosion potential was estimated over a continuous range of wind speeds and for all particle sizes. These results are not subject to any limitation with respect to threshold debates. So the data are very useful for determining Radioactive Soil Protection Levels regardless.

12. *Is the particulate sampling being performed to appropriately capture the dust that is resuspended during the wind tunnel tests (to include isokineticity and the design of sampling inlets)?*

The wind tunnel operators made adjustments from special tests to correct for possible nonisokinetic sampling. Inlet nozzles to the sample system were changed to closely match the isokinetic requirement. (Usually operator experience with a system shows that small differences in exhaust speed do not have a significant effect on isokinetic sampling. Experiments can be performed to prove effectiveness.) Isokinetic sampling in turbulent flows must rely on experiments because available theory only holds for laminar flows.

There remains one discrepancy that the authors have not satisfactorily explained. That is, the DustTRAK unit which was calibrated with a standard dust (Arizona road dust) did not agree with the mass sampling train. DustTRAK particle concentration data were always much lower than the collected mass would predict, so the authors adjusted the DustTRAK results upward. That certainly is the best thing to do so that errors are on the conservative side, and there is no reason to suspect the mass sampling train. But the DustTRAK low values may have been due to nonisokinetic undersampling of some type. The main function of the DustTRAK was to provide real time particle concentration data and this function was not seriously compromised by the data adjustments.

13. *Is the recurring process of deposition and resuspension being adequately treated by the wind tunnel? If the process is not fully treated, does this mean that the wind tunnel results will tend to over-predict or under-predict resuspension rates?*

It is a safe bet that deposition (or, redeposition) is not occurring in the test section of the wind tunnel for reasons stated previously. So particles are entering the sampling train that normally might be redeposited and held at a higher bonding energy. Thus the wind tunnel results would tend to over-predict erosion potential. This is not a serious problem since we would rather err on the conservative side to protect human health.

14. *What method has been used or should be used to verify the sampling efficiency of the wind tunnel?*

One of the best methods of verifying one type of sampling efficiency would be to use the wind tunnel on radioactively-labeled soil. But of course that was done here, quite independently, during the investigations following the wildfire. The observed plutonium concentration in the soil (pCi/g) was essentially the same across all soil sizes, and was also the same as observed on the suspended soil collected in the wind tunnel. There are other types of verifications that could be done, but there is no indication that the tunnel is underestimating suspended mass because of some inefficiency problem. In fact, it is my opinion that the wind tunnel overestimates the erosion potential; see question 8.

15. *While the wind tunnel results show increases in airborne dust release rates as the wind speed increases, intake of air by humans is activity dependent. How can this be taken into account in using data from the wind tunnel?*

Normally this is done using the mass loading approach. If we were to measure the activity in the suspended aerosols (pCi/g) and ratio it to the activity in an integrated soil sample (pCi/g) we would obtain what is known as an "enhancement factor". That is the effect of disturbance, fire, etc, would be expected to cause this ratio to increase at least temporarily because the aggregate structure may be broken down. For plutonium in soil, there are numerous cases documenting this enhancement factor. The National Council for Radiation Protection and Measurement has published a report (NCRP 129, 1999) showing how these values can be used to predict inhalation exposure to plutonium. The values are typically less than one in instances such as contaminated Rocky Flats, but may temporarily increase to values something less than 10. At the Nevada Test Site, a grass wildfire produced a plutonium enhancement factor of 3.5 (Shinn, 1992).

The wind tunnel results can be used to examine the enhancement factor to a limited extent. The soil sampled for wind tunnel studies near the wildfire area at Rocky Flats had an average plutonium activity of 1.71 pCi/g. The wind tunnel study of two plots (CB-22 and CB23) which were undisturbed had an average suspended dust TSP activity of 1.10 pCi/g and giving an enhancement factor of 0.6. This is less than one as expected. The wind tunnel study of two plots (CB-20 and CB-21) that were burned and disturbed by raking had an average suspended dust TSP activity of 1.77 pCi/g and giving an enhancement factor of 1. So there was no major enhancement factor change due to fire or disturbance. For all practical purposes the enhancement factor argument can be neglected at Rocky Flats as this data indicates. (In fact, in the risk assessments for Rocky Flats known to the author it has always been neglected.)

16. *Are the increases in air concentrations associated with increasing wind speeds as determined by the wind tunnel realistic and reasonable?*

For the purposes of this project we should use the estimated air concentrations as measured in the wind tunnel to document erosion potential and the effects of wildfire. It is the opinion of this reviewer that the results are likely to be an overestimate of suspended dust and erosion potential compared to the worst that would ever be observed in nature. But it is safer to err on the side of a conservative estimate of inhalation exposure. There is no better equipment at present than the wind tunnel method for

observing the effects of disturbance to plutonium-contaminated soil and there is no need to do additional studies. It should be possible to develop Radioactive Soil Action Levels with these results. Additional analysis of the data may be helpful, however.

Response to: Evaluate if the wind tunnel results are being properly used in developing input values for application in the selected dose (RESRAD) and risk (RAGS) models for establishing Radioactive Soil Action Levels at Rocky Flats.

This reviewer has found that the RSAL Task 3 Report and Appendix A, the data analysis by Haines in a Memo, and the table attributed to Nininger were all very helpful toward an objective method for establishing Radioactive Soil Action Levels.

I reviewed the section IV-6, Description of Problem Related to Mass Loading, starting on page 42 of the RSAL Task 3 Report. I do not disagree with the Conceptual Model presented in Figure IV-7, but would like to point out that it is not only "regrowth" that tends to stabilize a surface. Any process that causes reaggregation would do so. The current thinking in resuspension theory is that particles that are initially more loosely bonded may move locally to a site where the bonding is stronger. Since it is thought that the distribution of adhesive sites is log-normal, there always appears to be at least a few sites of very strong bonding. The net result is that air concentrations over contamination sites decreases inversely with time. This was observed in many countries in Europe following the Chernobyl disaster. So it is not always clear what the mechanism of bonding might be, only that there appears to be sufficient bonding of many types to cause the air concentrations to decrease. Because of the extensive data available for screening level purposes, the resuspension factor (a normalized air concentration) used in risk assessments is recommended (NCRP 129, 1999) to decrease as t^{-1} and this is in agreement with the wind tunnel observations at Rocky Flats. Rainfall certainly would also contribute to reaggregation. In the Appendix A of the RSAL Task 3 Report, and in the analysis of wind tunnel data by Haines and by Nininger, I saw that the air concentrations as well as the base erosion potential multiplier decrease as $t^{-0.69}$ which is a confirmation that recovery from fire is not unlike the decrease in resuspension factors observed following Chernobyl. We should all feel more confident that this is a unifying observation and in line with the NCRP recommendation for screening level risk assessments.

Further, there are discussions in the wind tunnel study reports and elsewhere about what the concentration of plutonium would be on the uppermost thin layer of the soil, since that surface is the eroding surface. It is somewhat amusing to hear arguments about the movement of plutonium downward and judicious arguments about the mobility of plutonium in various forms; since these discussions are moot in the face of the major transporting mechanism in the immediate soil surface layer—rainsplash. The kinetic energy of rain drops is so large and the impact on partially bare soils so great that soil material is transported upward and horizontally up to a meter in distance. (This is easy to observe by mounting a large white card extending vertically from the soil). The effect of

rainsplash is to thoroughly mix the upper few centimeters of soil within an annual rain cycle, and this effect has been discussed in conference proceedings (Shinn, 1992). So it is clear that soil plutonium concentrations are not sorted as might be expected in the uppermost layers.

I am in complete agreement with the choice taken by the Task 3 Working Group authors to use the observed mass loading distributions for Rocky Flats as the site specific data and preferred over any mass loading data inferred directly from the wind tunnel study. This is in part because I believe the wind tunnel method probably overestimates the erosion potential, but also because the site specific data are always preferred to data obtained under somewhat artificial means. I agree also with the "parameterization" of the fire effects for the purposes of RESRAD calculations, shown in Table IV-5, p 45 of the RSAL Task 3 Report. Since RESRAD is not a research model with the flexibility for complicated modification, this appears to be the best way to approach the effect of precipitation/drought, temporally elevated mass loading and the relative frequency of fire. The approach is much more realistic than other risk assessment approaches known to this reviewer, such as the RAC approach, for the case of fire effects.

I would like to comment once again that the wind tunnel study following the wildfire in a Rocky Flats contamination zone provided unexpected results about the plutonium levels in the surface soil and resuspended particulates. First, there was the discovery that the plutonium levels in the surface soil were lower than expected. Perhaps this is due in part to the mixing by rainsplash as well as by local deposition of uncontaminated soil. Secondly, and perhaps more importantly, the soil plutonium activities averaged 1.71 pCi/g across all size fractions, the suspended particle activity (TSP) averaged 1.77 pCi/g in the burned and disturbed (raked) sites, and the suspended particle activity (TSP) averaged 1.10 pCi/g in undisturbed sites. I interpret these data to mean that any potential enhancement effect of disturbance and fire on resuspension at Rocky Flats can be disregarded.

I have no further comments on the RSAL Task 3 or related work. I am quite pleased that uncertainties of fire effects and strong wind effects have been illuminated by the wind tunnel studies, and that progress has been made toward a final determination of the Radiation Soil Action Levels.

REFERENCES

1. NCRP 129 (1999) "Estimation of Soil-Originated Airborne Radionuclide Concentrations for the Assessment of Inhalation Effects: Methods and Uncertainties, Chapter 4: Dose from Inhaled Radionuclides," in *Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site-Specific Studies*, National Council on Radiation Protection and Measurement, Report No. 129.
2. Shinn J.H. (1992), "Enhancement Factors for Resuspended Aerosol Radioactivity: Effects of Topsoil Disturbance," *The Fifth International Conference on Precipitation Scavenging and Atmosphere-Surface Exchange Processes, Richland, WA, July 15-19, 1991*, Vol 3, 1183-1194, editors S. E. Schwartz and W. G. N. Slinn, Hemisphere Publishing Corp., Washington, Philadelphia, and London, 3 volumes, 1808 pp.